

# MYCOLOGIA

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## ILLUSTRATIONS OF FUNGI—XV

WILLIAM A. MURRILL

The specimens used for the accompanying figures were all collected in the vicinity of New York City. None of the species represented are known to be dangerously poisonous, and at least one of them is recognized as an excellent edible mushroom.

### *Chanterel minor* Peck

#### SMALL CHANTEREL

Plate 92. Figure 1.  $\times 1$

Pileus thin, fleshy, convex to expanded, irregular or depressed at times, gregarious, 1–2.5 cm. broad; surface glabrous, sub-rugose, ochraceous to orange; margin inrolled at first, entire or repand; context thin, pallid, mild, at length faintly peppery; lamellae decurrent, distant, very narrow, often forking, but seldom anastomosing, concolorous or somewhat paler; spores ovoid, somewhat one-sided, smooth, hyaline with a faint yellowish tinge,  $8-9 \times 4-5 \mu$ ; stipe slender, cylindric, equal, glabrous, shining, slightly striate at times, concolorous, usually solid, 2–5 cm. long, 2–4 mm. thick.

This tiny bright-colored species is known to occur on the ground in deciduous woods from Massachusetts to Alabama in the eastern United States and is reported from a few localities in the middle west.

### *Lepiota procera* (Scop.) Quél.

#### PARASOL MUSHROOM

Plate 92. Figure 2.  $\times 1$

Pileus soft, fleshy, ovoid to expanded, umbonate, solitary or

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gregarious, 8-16 cm. broad; surface radiate-fibrillose and rufescent beneath the cuticle, the cuticle thick, at first smooth and continuous, rufous to umber in color, at length torn asunder, except upon the umbo, into large irregular scales which become scattered and gradually fall away, margin deflexed, silky-fibrillose; context thick, soft, white; lamellae broad, close, white, at times yellowish or pinkish, tapering slightly behind, free, remote; spores ellipsoid or obovoid, apiculate, 1-2-guttulate,  $12-18 \times 8-12 \mu$ ; stipe tall, tapering upward from the bulbous base, hollow or fibrous-stuffed, the cuticle thin, flocculose, rufous or brownish, at length drawn apart into minute scales, 15-25 cm. long, 8-16 mm. thick, the base 2-3 cm. thick; annulus thick, soft, subcoriaceous, movable, apical.

This handsome edible species is found in thin soil in meadows, pastures, and open woods from New England to Alabama and west to Nebraska. It is also widely distributed in Europe and Asia, where it is highly esteemed as an article of food, in some places being dried in quantity for winter use. On account of its scaly cap and bulbous stem, it must be carefully distinguished from species of *Venenarius*.

#### **Chanterel cinnabarinus Schw.**

##### CINNABAR CHANTEREL

Plate 92. Figure 3.  $\times 1$

Pileus firm, thin, fleshy, convex to depressed or somewhat infundibuliform, often irregular in the larger specimens, gregarious or scattered, 1.5-3 cm. broad; surface smooth or slightly rugose, of soft compacted fibers, opaque, cinnabar-red, fading somewhat in the field and entirely in the herbarium; margin at first inflexed, undulate to lobed, concolorous; context whitish, tinged externally with red, thin, taste varying from mild to slightly acrid; lamellae long-decurrent, forked, interveined, distant, narrow, concolorous or slightly paler than the surface; spores ellipsoid, smooth, hyaline,  $8-9 \times 5 \mu$ ; stipe cylindric or tapering downward, terete, glabrous, smooth or slightly striate, concolorous, solid, 2-5 cm. long, 4-7 mm. thick.

This small species is conspicuous because of its brilliant coloring and occurs in abundance on the ground in deciduous or coniferous woods from New England to Alabama and west to Indiana and Ohio, as well as sparingly in certain parts of tropical America.

**Entoloma Grayanum** Peck

GRAY'S ENTOLOMA

Plate 92. Figure 4.  $\times 1$ 

Pileus convex to plane, gregarious, 5-8 cm. or more broad; surface smooth, glabrous, hygrophanous, dark-avellaneous to subumbrinous, margin entire, concolorous; context white, odor and taste farinaceous; lamellae adnate or slightly sinuate, subdistant, ventricose, white to rosy, the edges undulate; spores subglobose, angular, rose-colored,  $7-9\mu$ ; stipe equal or tapering downward, shining-white, longitudinally striate, glabrous, solid, white within, 6-10 cm. long and 1 cm. thick.

This species is quite common in woods in eastern North America during late summer and autumn. It is well to avoid species of *Entoloma* when gathering mushrooms for the table. Two European species, *E. lividum* and *E. sinuatum*, are recognized as poisonous.

**Ceriumyces fumosipes** (Peck) Murrill

SMOKY-STEMMED CERIOMYCES

Plate 92. Figure 5.  $\times 1$ 

Pileus convex, 4-7 cm. broad, about 1-1.5 cm. thick; surface tomentose, avellaneous with light-bay spots to umbrinous or dark olive-brown, very distinctly reticulate-rimose, the cracks becoming wider and whitish in color in older plants, while the areoles between contract almost into tufts, especially toward the margin; margin entire, fertile; context firm, fleshy, white, changing slowly and slightly to pale-blue, taste sweet; tubes plane in mass, somewhat depressed at maturity, equaling the thickness of the context, greenish-white to avellaneous; spores ellipsoid, smooth, deep ochraceous-brown,  $14-16 \times 7-8\mu$ ; stipe somewhat ventricose, solid, white within, changing slightly to bluish beneath the cuticle, 3-4 cm. long, 0.7-1 cm. thick, finely scabrous or scurfy, avellaneous-umbrinous to fulvous, paler above, distinctly pale bluish-green at the apex.

This species occurs sparingly in woods, especially on roadside banks, from New York to the mountains of North Carolina and west to Kentucky. It may be readily recognized by the pale-bluish-green band at the apex of the stipe.

***Ceratomyces communis* (Bull.) Murrill**

## COMMON CERIOMYCES

Plate 92. Figure 6.  $\times 1$ 

The usual form of this very abundant and widely distributed species was figured and described in MYCOLOGIA for March, 1910. The form here represented is peculiar in having a bright-red, very finely tomentose cap which does not become rimose-areolate, and considerably smaller tubes than in the usual form.

***Ceratomyces illudens* (Peck) Murrill**

## DECEIVING CERIOMYCES

Plate 92. Figure 7.  $\times 1$ 

Pileus convex, 3-7 cm. broad; surface dry, finely tomentose, olivaceous, yellowish-brown or grayish-brown, sometimes slightly tinged with red, especially in the center; context whitish or yellowish, unchanging, rather spongy; tubes plane or convex in mass, adnate to adnexed, bright yellow to melleous without and within, mouths large, angular or subcircular, usually larger near the stipe; spores oblong or subfusiform, olive-green fading to yellowish-brown tinged with green,  $11-13 \times 4-5 \mu$ ; stipe nearly equal, usually tapering at the base, glabrous, whitish or yellowish to light-bay above, pale-yellow below, 3-7 cm. long, 5-10 mm. thick, coarsely reticulate entirely to the base in fully developed specimens, but only at the top in small plants.

This species occurs in woods and copses from Vermont to Alabama in the eastern United States. The stipe is coarsely reticulate, the tubes bright-yellow, and the cap usually olivaceous to yellowish-brown.

NEW YORK BOTANICAL GARDEN.

## THE IDENTITY OF *CANTHARELLUS BREVIPES* AND *CANTHARELLUS CLAVATUS*

EDWARD T. HARPER

(WITH PLATES 93, 94 AND 95)

The plants illustrated in plates 93 and 94, accompanying this article, are frequently met with at Neebish, Michigan. They grow on the ground in damp mossy places or among needles in coniferous woods. We referred them at first to *Cantharellus brevipes* Peck, but the illustration of *Craterellus clavatus* by Fries<sup>1</sup> suggested that Peck's species is the same as *Craterellus* or better *Cantharellus clavatus* of Europe, and further study of other illustrations and descriptions of that species appears to prove the identity beyond doubt. *Cantharellus clavatus* has been figured many times in European works on mycology. One of the latest illustrations is that in Rolland's *Atlas Champignons* (pl. 52). The plant is really a *Cantharellus* and has been so called by Corda, Bresadola and others. The description in Saccardo's<sup>2</sup> *Sylloge* fits our plant except that the hymenium becomes pale ochraceous pruinose rather than "whitish pruinose from the spores," which is necessarily the case since the spores are ochraceous. In dried specimens the spore pruina appears whitish over the dark background of the hymenium unless special attention is paid to the color. The pruinose surface is very noticeable. The spore measurements,  $4-5 \times 10-12 \mu$ , agree with those of our plants exactly and also with those of *Cantharellus brevipes*.

*Cantharellus clavatus* has been reported from Maine by Sprague, according to Saccardo (l. c.) and Lloyd<sup>3</sup> has recognized it among plants sent to him from Montana, but he thought the spores of the Montana plant appeared hyaline under the microscope. The spores in our plants are pale-ochraceous.

<sup>1</sup> Fries, *Sverige Svamp. pl. 91*. 1836.

<sup>2</sup> Saccardo, *Syll. Fung.* 6: 519. 1888.

<sup>3</sup> Lloyd, letter 44, note 56.

Peck<sup>4</sup> described and illustrated *Cantharellas brevipes* in 1880. He has also recorded two other collections.<sup>5</sup> The fact that it is so rare in New York State and that it is really a *Cantharellus* accounts for its not being recognized as Persoon's species.

The illustrations in plates 93 and 94 show the appearance of the Neebish plants. The plants are usually quite regularly obconic or turbinate with the pileus truncate or slightly depressed and the acute margin even or slightly wavy as in plate 93. This is the form illustrated by Peck. The hymenium is a network of folds and wrinkles. The wrinkle-like lamellae are more nearly parallel toward the top and more reticulate below, the reverse of the condition in *Cantharellus floccosus*. Under favorable weather conditions the plant becomes broader and the margin is thin and lobed as in plate 94 A. Sometimes these luxuriant forms grow in dense clusters as in B. Sometimes the plants appear branched from a common stem. Sometimes they are irregular and the lobes on the pileus very long as in Britzelmayr's illustration (tab. 698). The flesh of our plants is whitish. The colors vary considerably. The pileus is yellowish or umber with tinges of purple or violet. It becomes faded, scaly and pitted when old. The hymenium is usually deep violet with flesh-colored tints. A whole series of variously colored forms have been noted in Europe.

It has been recognized already that the plants referred to as *Craterellus clavatus*, by Peck,<sup>6</sup> are *Craterellus pistillaris* Fries. Peck speaks of their close resemblance to *Clavaria pistillaris* and describes the margin of the pileus as obtuse and crenate. *Craterellus pistillaris* has been taken in this country for a form of *Clavaria pistillaris* by Atkinson<sup>7</sup> and Lloyd (l. c.). Fries said *Craterellus pistillaris* was frequently found in pine woods about Upsala where true *Clavaria pistillaris* was never found. It is interesting that our plants illustrated in plate 95 are found in coniferous woods at Neebish, Michigan, and we have never seen *Clavaria pistillaris* there. Only once has the plant been collected at Neebish, and then not in coniferous woods. It is

<sup>4</sup> Peck, Ann. Rep. N. Y. State Mus. 33: 21, pl. 1, f. 18-20. 1880.

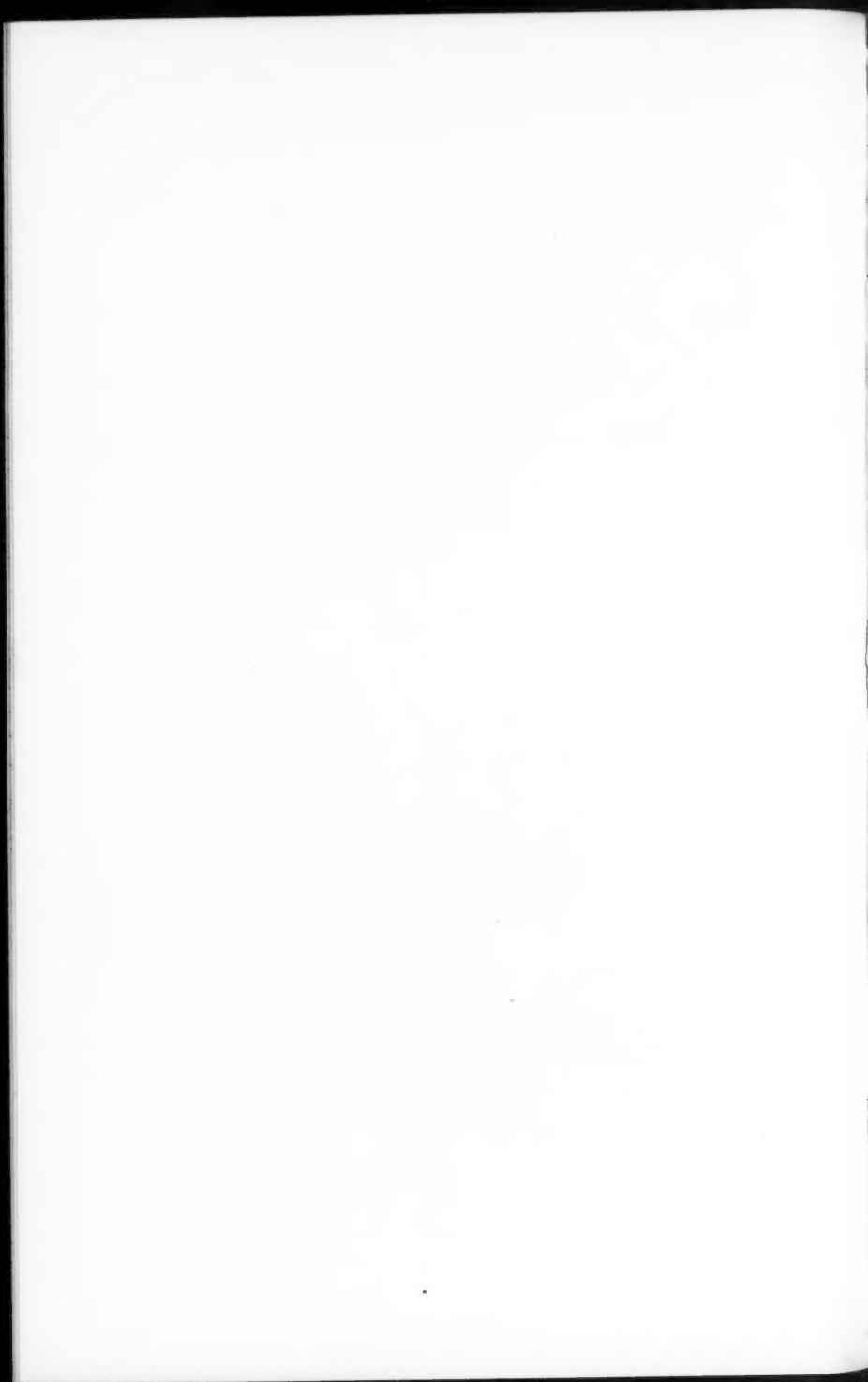
<sup>5</sup> Peck, Ann. Rep. N. Y. State Mus. 51: 298. 1897.

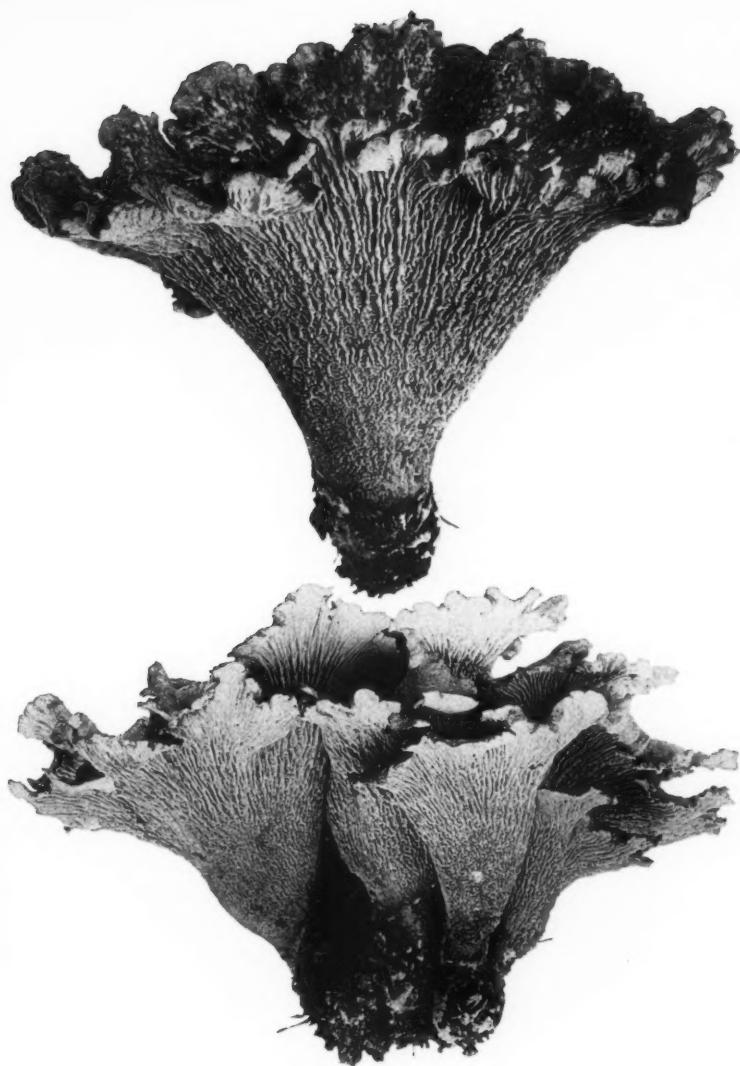
<sup>6</sup> Peck, Ann. Rep. N. Y. State Mus. 32: 35, 1880, and Bull. N. Y. State Mus. 2: 48. 1887.

<sup>7</sup> Atkinson, Mushrooms, 203. 1903.



CANTHARELLUS CLAVATUS (PERS)





CANTHARELLUS CLAVATUS (PERS)



CRATERELLUS PISTILLARIS, FR.

very common in frondose woods elsewhere in Michigan and Wisconsin. Other collectors may not have this experience however.

Atkinson and others are undoubtedly right in considering Fries' plant a variety of *Clavaria pistillaris* and it should be placed in a group with that species. Fries recognized the similarity of the two but probably placed the plant in the genus *Craterellus* because of the depressed pileus. The hymenium is usually continuous to the apex. Schaeffer's figures (290), are supposed to represent this form but they appear to us more like small forms of *Cantharellus clavatus*.

Plate 95 shows the common forms of the plant as found at Neebish: (A) a form with the hymenium nearly smooth and the margin obtuse and even; (E) a form with a wrinkled hymenium and margin of the pileus crenate; (B) a very small plant; (C) the extreme form in old plants with the hymenium very rugose and pitted; (D) a wrinkled pileus with slight umbo in the center. The plants are spongy and soon become hollow. The base of the stem is often bulbous. The colors are reddish-brown like *Clavaria pistillaris*, but the hymenium is often dull violet with yellowish tints above and on the pileus. The spores are  $6-7 \times 10-12 \mu$ ; basids club-shaped,  $12 \times 60 \mu$ ; sterigmata  $10 \mu$  long. The spores of *Clavaria pistillaris* are in our specimens ovate,  $4-5 \times 8-11 \mu$ . The flesh of our plants is not nearly as solid as that of *Clavaria pistillaris*. The two forms, however, run together. Hard's<sup>8</sup> illustration of *Clavaria pistillaris* (fig. 396), appears like an intermediate form, and *Craterellus corrugis* Peck,<sup>9</sup> must be something similar. Forms of *Clavaria pistillaris* with the apex pinched in are well known.

A letter from Mr. C. G. Lloyd confirms both of the above identifications. Mr. Lloyd has examined Persoon's type of *Merulius clavatus* at Leiden and a co-type specimen of Fries' *Craterellus clavatus* at Kew. He has also seen a type specimen of Fries' *Craterellus pistillaris* at Kew and Peck's specimens at Albany.

<sup>8</sup> Hard, Mushrooms. f. 396. 1908.

<sup>9</sup> Peck, Bull. Torrey Club 26: 69. 1899.

## THE STRUCTURE OF SIMBLUM SPHAERO- CEPHALUM

HENRY S. CONARD

(WITH PLATES 96 AND 97)

In October, 1911, Miss Winnie Gilbert, a student at Grinnell College, Iowa, brought in a specimen of the pink stink-horn, *Simblum sphaerocephalum* Schlecht. It was found on the north side of a deep railroad cut one mile west of Grinnell. Further search in this place resulted in the collection of several mature specimens and a number of "eggs." They grew about half way up the slope, facing south, on Marshall silt loam that had slid down the bank many years ago, and at about the level of the boundary between the loess and the glacial drift. Perhaps there are special moisture conditions at this level, though other vegetation does not suggest this. With them was *Poa pratensis* as dominant plant, as well as seedlings of *Acer negundo*, *Physalis* spp., *Aster* spp., etc. Two or three weeks later my colleague, Professor H. W. Norris, found specimens on a hillside above Skunk River, three miles southwest of Turner Station (southeast corner of section 5, Richland Township, Jasper County, Iowa). Some of the smaller "eggs" were cut open and killed in chromacetic fluid and later sectioned on the serial microtome. The rest of the material was preserved in alcohol. The following studies were made of the preserved material. My best alcoholic specimens have since been deposited with Professor Macbride at the State University of Iowa, Iowa City. A brief account of this find was presented to the Iowa Academy of Science in April, 1912.<sup>1</sup>

*Simblum sphaerocephalum* was originally described by Schlechtendal (1861) from Argentina, where it is common. Similar plants have been collected in southern Brazil and in Venezuela, and described under different names. In North America it is known from Astoria and Cold Spring Harbor, Long Island;

<sup>1</sup> Proc. Iowa Acad. Sci., 19: 103. 1912.

Nebraska; Kansas; Washington, D. C.; Talbot County, Md.; and Texas (Lloyd, 1909, p. 67; Long, 1907). We follow Fischer (1890, p. 59) in reducing to synonymy the names *S. rubescens*, *S. australe*, *S. Lorentzii*, and *S. pilidiatum*. In view of the rarity of this plant in the United States, we offer the following detailed observations.

The white volva, flesh-pink stalk and receptaculum, and umber-brown spore-mass make this fungus a curious and striking object (fig. 5). Its odor is somewhat nauseous, but not strong. The size of our plants is shown by the following tables of measurements:

MEASUREMENT OF MATURE PLANTS, IN CM.

Total Height	Length of Stalk	Length of Head	Diameter of		
			Head	Stalk	Volva
5 <sup>2</sup>	3	1	1.75	1.2	2.3
7	6.3	0.7	1.8	1.3	
5.5		0.7	1.3	1.0	
8.5	6.5	1.5	2.5	2.1	3
10 (?)	8.0	1.5	2 (?)	1.8	3
7	5.8 (?)	1.0	1.5	1.3	
5.5	4.3 (?)			1 (?)	
					2.5 <sup>3</sup>

MEASUREMENTS OF "EGGS," IN CM.

Height.	Diameter.	Rhizomorph.
2.2	1.5	
2.6	1.7	1.9
2.9		
2.3	2.15	3.0
1.9	1.6	
	1.5	

When lifted carefully each plant was found to have a stout white rhizomorph running into the ground (figs. 1, 5). These strands are smooth, solid, and gently tapering. The longest we have is 3 cm. with a diameter of 2 mm. The egg-stage is obconical in shape (fig. 1), white, rather firm to the touch, but not turgid. When cut in half lengthwise the "egg" shows first a tough, white peridium (fig. 1), then a thick layer of firm, translucent, gelatinous matter traversed by strands or trabeculae of denser white tissue. On comparing cross-sections (fig. 2) it is seen that these

<sup>2</sup> Including rhizomorph.

<sup>3</sup> Has also a rhizomorph 2 cm. long.

strands are really anastomosing partitions, connecting with the peridium externally and with the bars of the receptaculum within. The gelatinous layer is therefore divided up into many irregular longitudinal chambers. A similar arrangement of partitions in the volva jelly is described by Fischer (1901) in *Simblum periphragmoides*, and by Long (1907) in this species.

So far as is shown by the rather advanced stages at our disposal, *Simblum sphaerocephalum* agrees precisely in structure with other Clathraceae as described by Fischer (1890-1910). The stalk of the receptaculum is traversed by a central strand, (S) of gelatinous hyphae, which is continuous with the gelatinous filling of the chambers of the stalk (figs. 1, 3). The pseudoparenchymatous tissue is composed of small spherical cells, arranged in a network of anastomosing plates which form the walls of the chambers (figs. 3, 7, 8). These walls are much folded in the egg stages. Though the chambers seem to be all connected with one another and with the central cavity of the stalk, they do not connect definitely with the tissues surrounding the stalk. Elongation of the stalk is manifestly due to a great increase in size of the pseudoparenchyma cells, as shown by figures 7 and 8. Though these are not taken from the same plant, their evidence seems conclusive. Coupled with this enlargement is a general expansion of the stalk in all directions, a straightening of the folds of the chamber walls, and liquefying of everything except the pseudoparenchyma.

In the head region, the bars of the receptaculum (*Rp*) are found on the surface of the gleba, in full view when the volva-jelly is removed. From each bar a plate of permanent hyphal tissue (*Pl*) extends to the peridium. Since the receptaculum is net-like, these plates enclose prismatic spaces (*G*) which correspond in position and number to the meshes of the network. It is in these spaces that the volva-jelly is contained. In our specimens (and also in *S. periphragmoides*, according to Fischer, 1901) these spaces bend downward parallel to the stalk, and end near the base of the "egg." Doubtless they originate when the "egg" is very young, and before the stalk is formed (Cf. text fig. 1, *G*). As growth proceeds, the volva extends by enlargement of its upper parts (above  $\phi$ , text fig. 1), and the stalk is

intercalated beneath the head. Meanwhile the plates elongate *pari passu*, resulting in the condition shown in text fig. 3. If this be true, as seems almost certain, the stalk would seem to be an organ of much more recent origin than the head of the receptaculum. It may be regarded as an extreme development of the basal ring of the receptaculum of *Clathrus* (text figs. 1, 2,  $\alpha$ ). This agrees with the generally accepted view that *Clathrus* is one of the most primitive of the Clathraceae.

Fischer (1890, p. 11) supposes that the difference between the early stages of development of *Simblum* and *Clathrus* would be that in the former the branches of the central strand come off

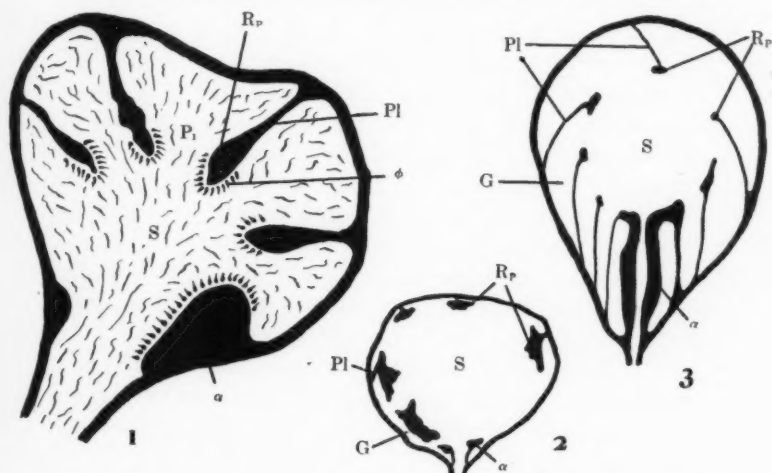


FIG. 1.—1. Vertical section of very young egg of *Clathrus cancellatus*, from Fischer 1890, pl. 1, f. 3.—2. The same, mature egg; l. c. f. 6.—3. Diagram of vertical section of mature egg of *Simblum sphaerocephalum*, a lowest ring of receptaculum; other letters as in plate.

higher up than in the latter ("Der Unterschied der ersten Fruchtkörperanlage von *Simblum* gegenüber derjenigen von *Clathrus* besteht also darin, dass vom Centralstrang hier erst weiter oben als dort Zweige abgehen"). But if the central strand branches higher up, there should be no volva-jelly around the stalk—unless the branches force themselves down between the layers of the peridium and the plates, parallel to the stalk. It seems much

more reasonable to say that the branching of the central strand takes place when as yet there is no stalk, exactly as in *Clathrus* (text fig. 1). The branches are then fixed to the peridium, as it were, at their outer ends. When their inner ends are raised up by the intercalation of a stalk, the outer parts of the branches are drawn out into vertical columns, parallel with the stalk. Thus the stalk of *Simblum*, originating as a sterilized basal portion of the receptaculum, becomes an independent organ, bearing the fertile receptaculum at its upper end. The usefulness of such a stalk for the better distribution of the spores, as Moeller (1895) suggests, cannot be doubted.

From a study of Burt's (1894) description of *Anthurus borealis* and Fischer's (1910) of *Ascroë*, it appears that in these forms also the stalk develops in the manner outlined above, rather than by a branching of the rudiment of the central strand higher up, and a forcing of the tips of the branches downward between the layers of the peridium. Indeed this view was mentioned as probable by Burt (1894, p. 495). It is indicated also by Moeller's description of the development of *Colus Garciae* (1895, p. 39). A study of the plates in the volva-jelly of *Colus hirudinosus*, *Kalchbrennera*, and *Laternea* would be helpful in this connection. Tulasne's (1846) figure of the egg of *Colus hirudinosus* shows the plates from the fertile parts of the receptaculum to the volva, but shows no plates in the region of the stalk. His figure 16 is a transverse section of the fertile portion and figure 15 an outside view of the entire egg. The matter is therefore not settled for this species.

In *Lysurus*, *Anthurus* and *Ascroë* it is possible to consider the stalk as a fusion of the lower vertical bars of a clathrate receptaculum. *Clathrella chrysomycelina* and *Laternea* apparently lead to such a view. In *Simblum* there is no indication whatever of such an origin. Now, in all stalked Clathraceae, the stalk is surrounded by a sheath of gelatinizing hyphae, to which the plates attach, as in *Simblum*. But in the fertile portion the plates attach directly to a line or furrow along the arms or branches of the receptaculum. It seems reasonable therefore to believe that the stalks are homologous structures throughout the family, and of the same nature as described for *Simblum*. The sheath of the

stalk is then the place of attachment of the plate tissue to the lowest horizontal bars of the receptaculum, which has become extended into a sheath as the bars elongated to form the stalk.

The superficial position of the bars of the receptaculum in the head of *Simblum sphaerocephalum* has already been remarked (fig. 1). In this it differs markedly from *S. periphragmoides* (Fischer, 1893, 1900, 1901) whose bars are deeply embedded in the gleba. On critically examining the relation of gleba to receptaculum, we find in many cases gleba-chambers bounded on one side by fertile hymenium and on the other by pseudoparenchyma of the receptaculum-arm (figs. 9, 12). The transition from hymenium to pseudoparenchyma, however, is not gradual, but abrupt. Sometimes a narrow strip of tramal tissue lies between them. In many cases it is evident, so far as sections can prove, that the tramal hyphae are continuous with the pseudoparenchyma (fig. 10). Thus the pseudoparenchyma has a double origin. Indeed one frequently finds cavities separating the portions of different origins (fig. 10). These facts support Fischer's view, proposed in 1890, and proven for *Dictyophora irpicina* in 1910 (*b*), that the pseudoparenchyma represents sterile hymenial tissue, or a hymenium of paraphyses without basidia. In this case the cavities in the pseudoparenchyma of *Simblum* may be considered to be rudimentary gleba-chambers (fig. 10, *f*). Burt (1894) maintained that the pseudoparenchyma of *Anthurus borealis* is of strictly "cortical" nature, and has no connection with the surrounding gelatinizing hyphae. This idea was apparently drawn chiefly from sections in the stalk region, where the tissues are much more sharply separated. After the first rudiments of the stalk are formed as the lowest mesh of a net-like receptaculum, according to our theory, the further development of the stalk tissues may be quite independent of one another. Thus Burt's observations would be entirely right, and in no contradiction with Fischer's (1900) and my own. In one of my plants of *Simblum* two bars of receptaculum tissue were found near the center of the head, completely embedded in the gleba (fig. 6). Following these upward, they joined one of the upper bars of the receptaculum. Another specimen showed bars of the receptaculum extending deep into the gleba. These irregularities might

easily occur if hymenium and pseudoparenchyma are homologous tissues. Certain patches in the midst of the branches of the central strand in some of my sections give an appearance, in texture and staining, of a tissue intermediate between hymenium and pseudoparenchyma. Unfortunately gelatinization is so far advanced that no details are available. The center of each patch is occupied by numerous globular bodies of about the size and color of spores.

Fischer's (1890, p. 7) suggestion that the hymenium is fertile wherever it lines a cavity and sterile when two layers are appressed without a space between, is untenable. Not only is pseudoparenchyma developed adjacent to gleba-chambers (fig. 9), but basidia are borne in such narrow chambers that the space is literally obliterated (fig. 12). Moeller (1895, p. 31) has already emphasized these objections to Fischer's view. The stimuli which guide the development of an embryonic tissue must be much more profound than this.

The gleba of *Simblum sphaerocephalum* is traversed by stouter strands of tissue similar to that of the trama, constituting the "branches of the central strand (*P*)" of Fischer. Each such branch (figs. 1, 11) runs radially outward from the central gelatinous tissue of stalk and head, to merge into the volva-jelly at the middle of one of the meshes of the receptaculum. Each mesh is traversed by one such branch. Some branches are rod-like and reach the surface of the gleba in a circumscribed spot. Others are ribbon-like, and form a line on the surface of the gleba. Tangential sections of the surface of the gleba show the gleba-chambers as narrow branching slits radiating from the branch of the central strand and nearly at right angles to the bars of the receptaculum. This indicates an origin such as Fischer has described in other Clathraceae. The chambers probably result from the growth of trama-plates from the branch of the central strand toward the bars of the receptaculum. But no order was found elsewhere in the arrangement of the trama-plates or gleba-chambers.

In all of our material the dense mass of spores hides the basidia. Probably these had already begun to gelatinize. We found one basidium, apparently in normal condition. It was

nearly globular (fig. 4), with a short constricted base, and two short sterigmata at the apex. The basidium is about  $2.5\ \mu$  in diameter and  $4.5\ \mu$  tall, with sterigmata about  $0.5\ \mu$  tall. The spores are ellipsoidal, with a single large nucleus, and measure  $3\ \mu$  by  $1.5\ \mu$ . These dimensions, so characteristic of Phalloids, are of the same order of magnitude as those of bacteria—a fact which coincides with the idea that both of these groups of plants are distributed by flies.

#### SUMMARY

1. *Simblum sphaerocephalum* Schlecht., a common fungus in parts of South America, is now known from New York, Maryland, District of Columbia, Iowa, Nebraska, Kansas, and Texas. It shows every essential character of the Clathraceae.

2. The stalk elongates by enlargement of the cells of the pseudoparenchyma.

3. The bars of the fertile receptaculum are superficial on the gleba.

4. The plates which divide the volva-jelly are vertical in the region of the stalk, enclosing a mass of jelly for every mesh of the receptaculum. Their position is believed to be due to the late development of the stalk in a rudiment which would be identical in early structure with that of a *Clathrus*. The stalk of *Simblum* is therefore a highly developed basal ring of a clathrate receptaculum, and not a fusion of vertical columns.

5. Pseudoparenchyma of the receptaculum may be regarded as sterile hymenium.

6. In the superficial portions of the gleba, at least, the chambers originate by growth of trama-plates from the branches of the central strand toward the receptaculum-arms.

For use of the literature which has made this paper possible, I am indebted to the generous loan-system of the Missouri Botanical Garden. To the officers of the Garden I wish to extend hearty thanks. The photomicrographs are by Mr. Paul M. Smith.

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## EXPLANATION OF PLATES

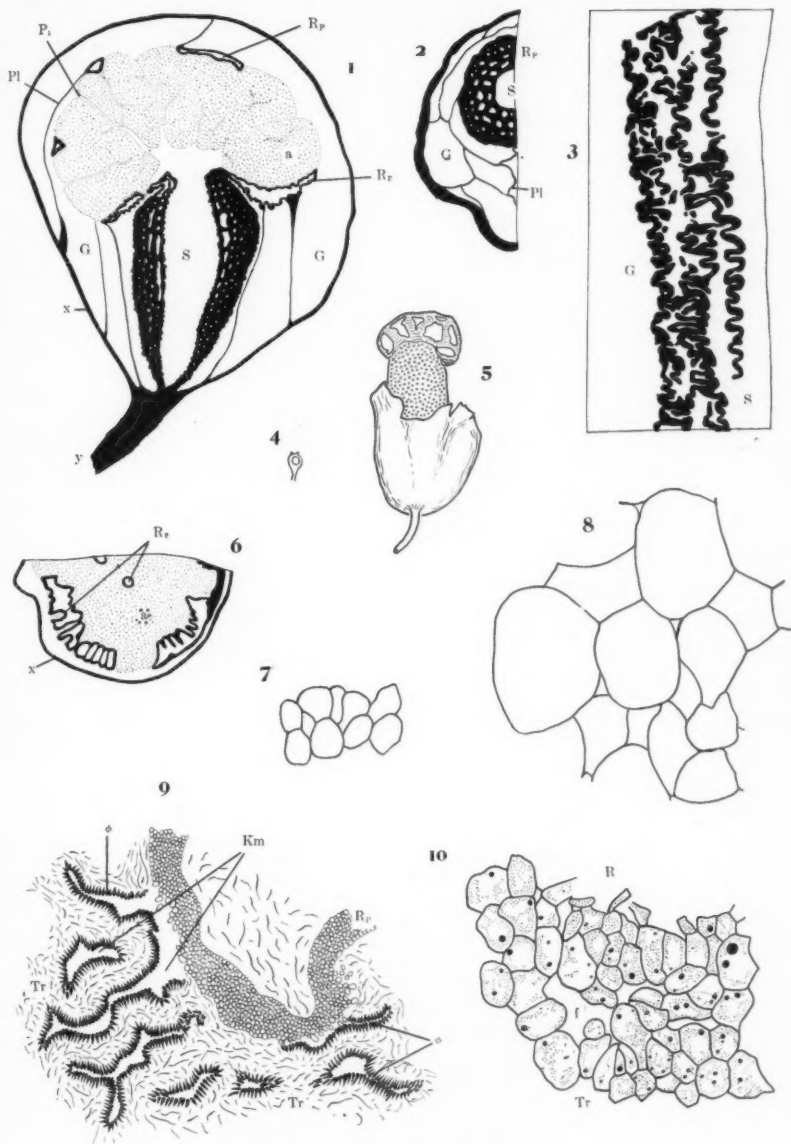
Key to index letters, the signs being mostly those used by Fischer. The figures are all of *Simblum sphaerocephalum*.

*a*, gleba.

*f*, rudimentary gleba-chambers in pseudoparenchyma of receptaculum.

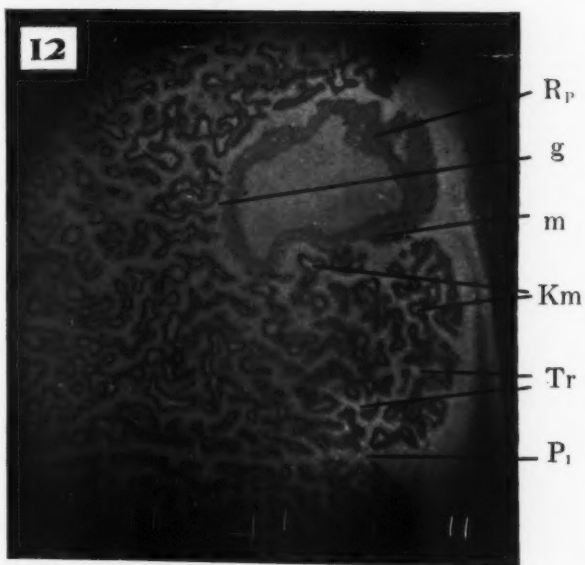
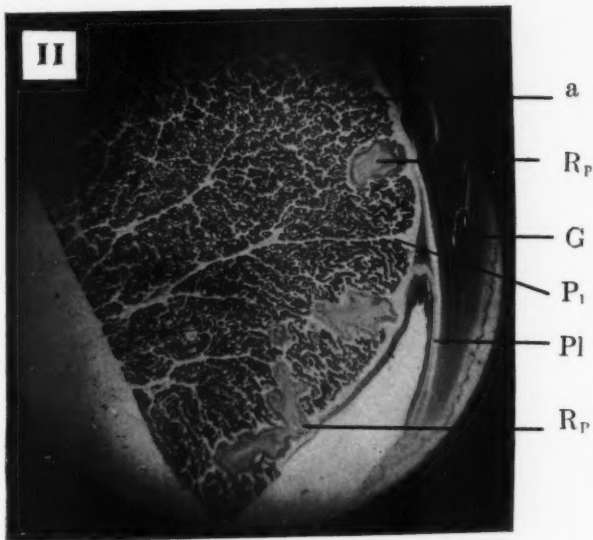
*G*, gelatinous part of volva.

*g*, gleba-chamber bounded partly by basidial layer and partly by pseudoparenchyma of receptaculum.

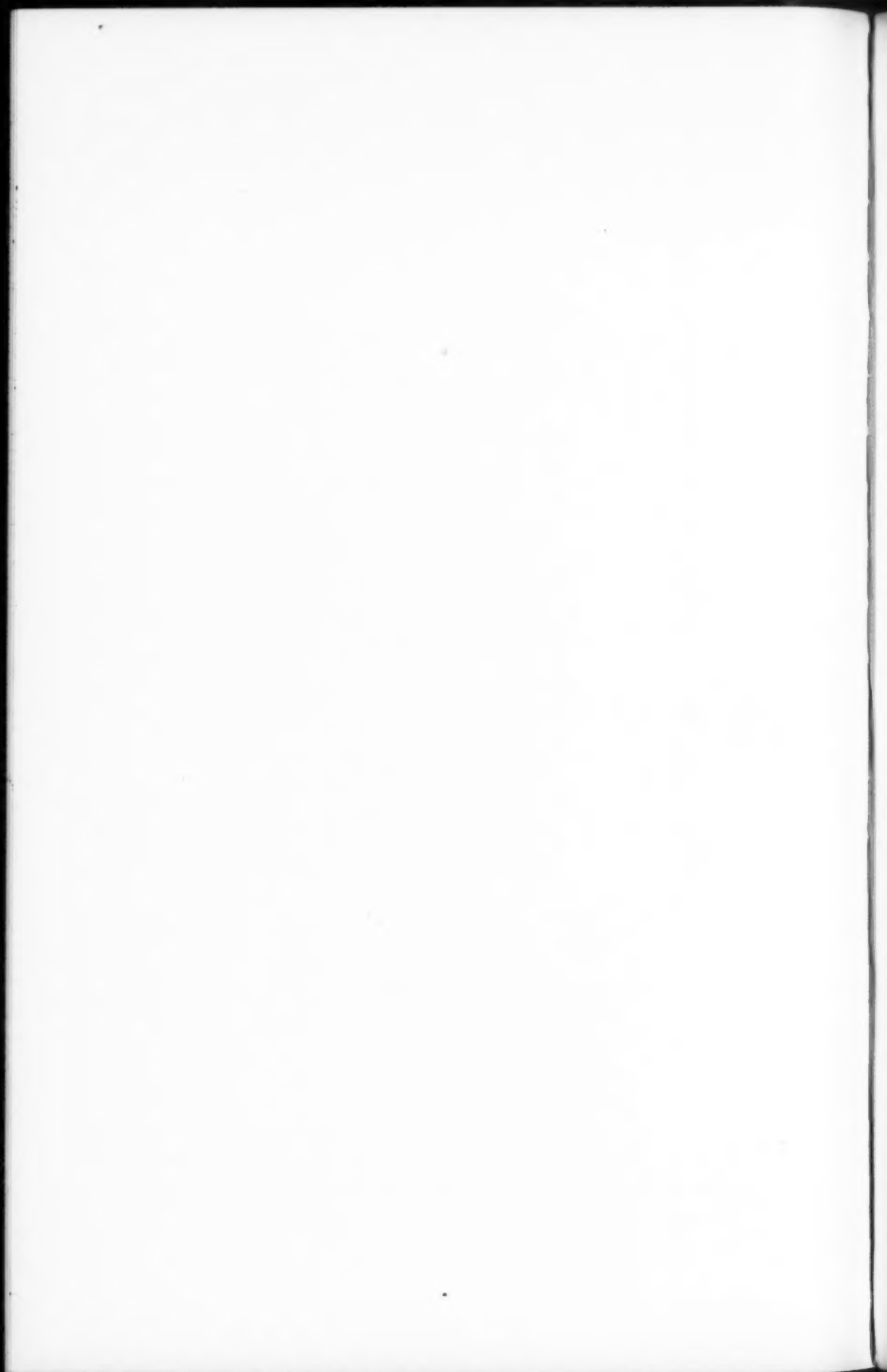


SIMBLUM SPHAEROCEPHALUM SCHLECT.





SIMBLUM SPHAEROCEPHALUM SCHLECT.



- Km*, gleba-chamber.  
*Pl*, plate-like partition in volva-jelly.  
*P*, branches of central strand.  
*R*, cavity of arm of receptaculum (gelatinous).  
*Rp*, receptaculum.  
*S*, central strand of gelatinizing hyphae.  
*Tr*, trama-plates.  
*x*, peridium.  
*y*, rhizomorph.  
*a*, lowest ring of receptaculum.  
 $\phi$ , basidial layer (hymenium).

PLATE XCVI

1. Longitudinal section of nearly mature egg, measuring 2.35 cm.  $\times$  2.15 cm. Camera sketch.
2. Transverse section of egg through stalk, showing the partitions in the volva-jelly. Camera sketch.
3. Folded pseudoparenchyma tissues in longitudinal section of stalk in egg stage. The cavity of the stalk is on the right, *S*, and the volva-jelly (*G*) on the left. Camera sketch.
4. Basidium, from a microtome section. Camera drawing.
5. Mature *Simblum* 5 cm. tall. Camera sketch of alcoholic specimen.
6. Transverse section of halved egg, through middle of head. Camera sketch.
7. Cells of pseudoparenchyma of stalk from egg stage; camera drawing.
8. Cells of pseudoparenchyma of stalk teased out from a fully elongated specimen; camera drawing with same magnification as fig. 7.
9. Section of receptaculum arm and gleba; semi-diagrammatic camera sketch. From (*g*) in fig. 12.
10. Transverse section of pseudoparenchyma of arm of receptaculum, showing rudimentary gleba-chamber (*f*). Tramal tissue below (*Tr*) and cavity of arm (*R*) above. Camera drawing.

PLATE XCVII. PHOTOMICROGRAPHS

11. Transverse section of head of egg stage.
12. Portion of the same section, more highly magnified.

GRINNELL COLLEGE,  
 GRINNELL, IOWA.

# A METHOD OF DETERMINING IN ANALYTIC WORK WHETHER COLONIES OF THE CHESTNUT BLIGHT FUNGUS ORIG- INATE FROM PYCNOSPORES OR ASCOSPORES<sup>1</sup>

F. D. HEALD

(WITH PLATES 98-101)

## INTRODUCTION

In studying the dissemination of the chestnut-tree blight fungus [*Endothia parasitica* (Murr.) And. and And.] it is sometimes of importance to be able to determine whether the colonies of *Endothia* appearing in poured plates originate from pycnospores or ascospores. This is especially true in case of the analysis of soil for the presence of the fungus, the quantitative determination of viable spores retained in spore traps, and other similar operations.

During the past winter thousands of cultures of the blight fungus have been made, especially in studying the problem of dissemination, but before beginning the work the method here outlined was worked out, as it appeared to the writer of fundamental importance.

At first thought the possibility of differentiating ascospore and pycnospore colonies seemed somewhat remote, but the striking difference in size of pycnospores and ascospores offered the first clue to the problem. The approximate dimension of the spores (ascospores  $5 \times 10 \mu$ ; pycnospores  $1 \times 3-5 \mu$ ) gives rather an imperfect notion of their difference in magnitude, but calculation will show that the ascospore of average size has a volume about fifty times that of the average pycnospore. It seemed evident then that the greater size of the ascospore would result in a more rapid growth of the colonies originating from them.

<sup>1</sup> Work in cooperation with the Pennsylvania Chestnut-Tree Blight Commission, Philadelphia, Pa.

The medium found most suitable for this work was 3 per cent. dextrose agar, plus 10, made according to the standard bacteriological formula. The comparative rate of growth from ascospores and pycnospores was first tested in this medium by means of hanging-block cultures. The pycnospores used were obtained from spore-horns grown in damp chambers in the laboratory. The ascospores were obtained by placing flamed object slides over moistened bark bearing perithecial pustules and collecting the expelled spores. In making the pycnospore cultures a drop of sterile bouillon was placed on a flamed slide and a small spore-horn added to it. One or more dilutions were made from this to other drops of sterile bouillon and a short streak was made from the final dilution upon the surface of the cover glass, after which the streak was covered with melted agar cooled to 42° C. In making the ascospore cultures a drop of sterile bouillon was placed over a spore print on a slide. Dilutions were made from this to a second slide, and the planting made directly from the spore dilution.

By these methods there was never any trouble in securing pure cultures in the hanging drop cells.

#### GERMINATION OF PYCNOSPORES AND ASCOSPORES

During the first part of the germination period the pycnospore increases in size until it is oval or oblong in form and slightly in excess of the diameter of the germ tube that is to be produced (plate 98, figs. 1-3). A hypha begins to grow out from one end of the spore and this is generally followed later by one from the opposite end so that at temperatures from 22° to 25° C., only an unbranched linear aggregate has been produced at the end of 24 hours. During the next 24 hours, however, branching generally begins, the first branch originating a little beyond the limits of the spore, thus producing a distinct Y-type of growth (plate 98, figs. 4-6).

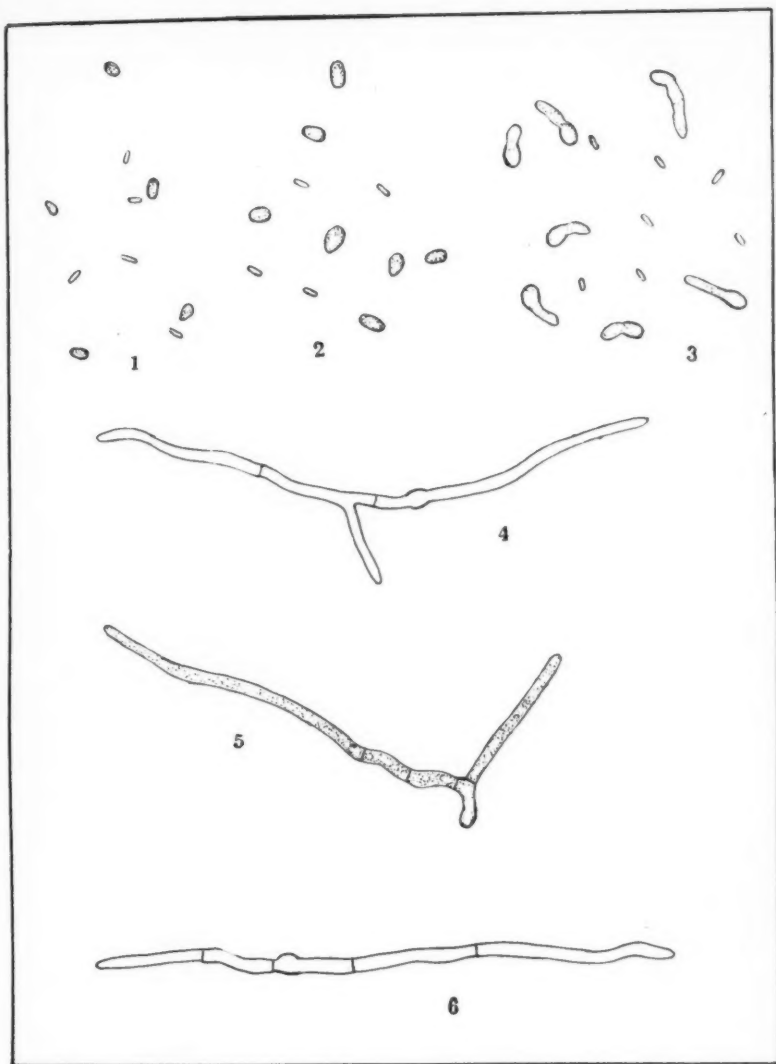
Each cell of an ascospore generally gives rise directly to at least one vigorous hypha, but occasionally one cell fails to germinate. In many spores each cell gives rise to a lateral hypha a little later. In case a lateral hypha is not formed directly from

the spore cell, one originates a few mikrons beyond the spore wall, giving in the majority of cases a growth with pronounced decussating branches (plate 99, figs. 1-5).

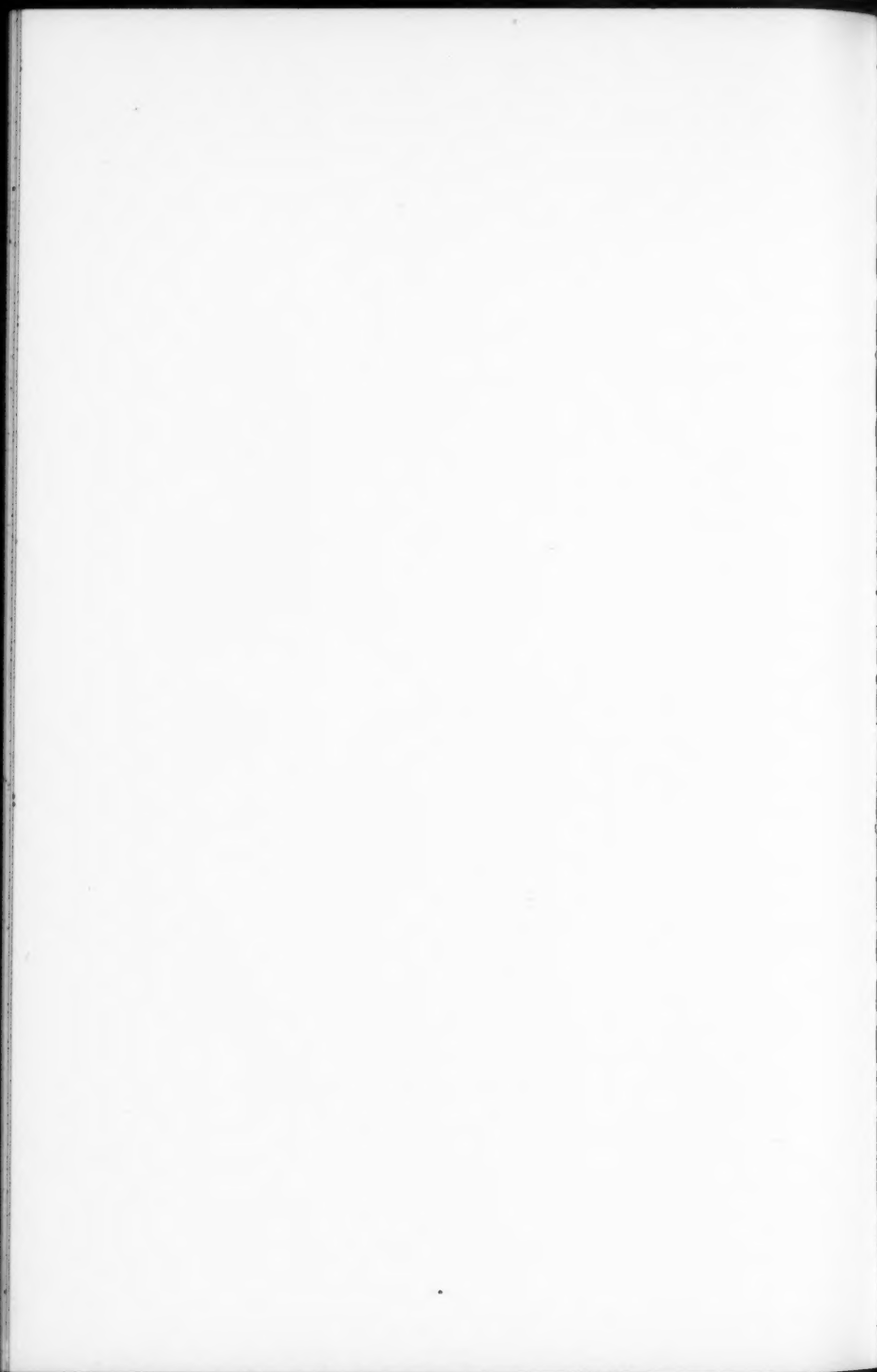
Tests of the comparative rate of growth of pycnospores and ascospores were first made at 22° C., but it was found by later work that 25° C. gave a more pronounced difference. Camera lucida drawings were made at hourly intervals for the ascospores after the first eight hours and at intervals of two hours for the pycnospores. At the end of eight hours the ascospores produced a strong hypha from each cell, while the pycnospore had not yet swollen to its full size; after 22 hours the pycnospore had produced a short unbranched hypha with little or no septation, while the ascospore had produced a much branched linear aggregate of cells (plate 100). The series of drawings shown will serve to emphasize the pronounced difference in the growth from the pycnospores and ascospores.

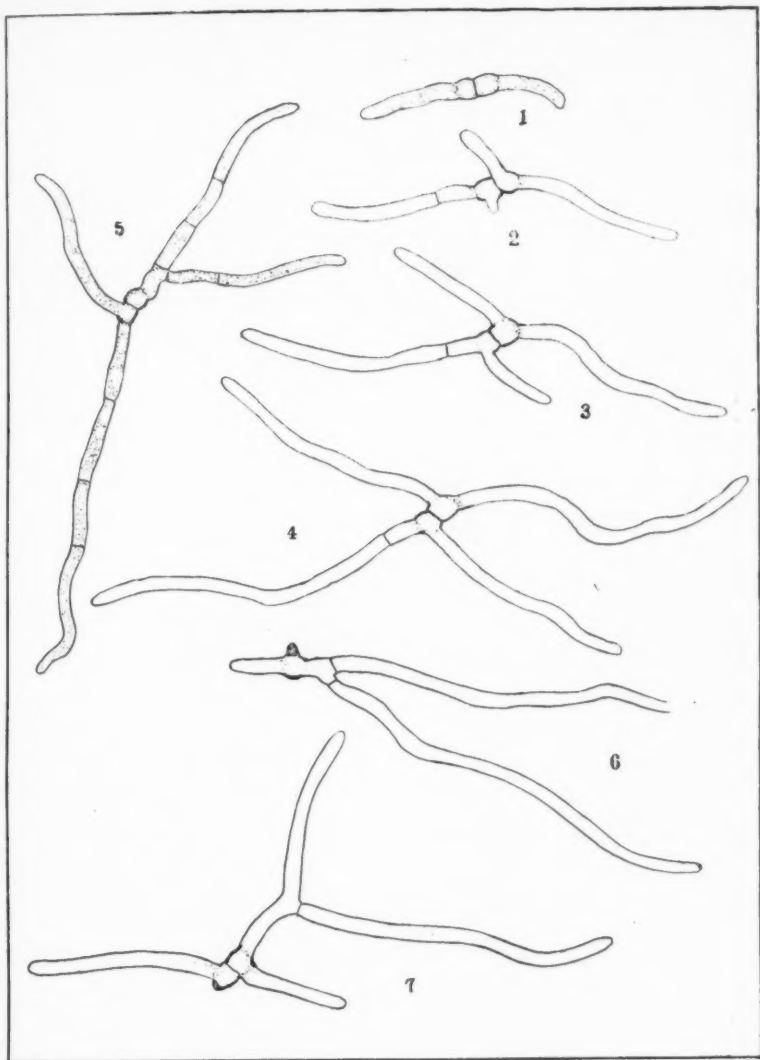
#### PLATE CULTURES

The marked difference in the rate of growth from pycnospores and ascospores suggested the strong probability of being able to differentiate the two types of colonies in plate cultures by the size of the colonies at the end of a certain time. Various culture media were tried but 3 per cent. dextrose agar, plus 10, again appeared to be the most suitable. The poured plates were made in the usual manner from spores obtained in the same way as for the hanging-block cultures, and practically pure cultures of the blight fungus were always obtained. The cultures were held at a constant temperature of 25° C. All of the tests made showed that ascospore colonies became visible and conspicuous when the pycnospore colonies were still minute and invisible to the naked eye. At the end of three days' time, colonies originating from ascospores were 0.5-3 mm. in diameter, the size depending upon the crowding in the plate, while those originating from pycnospores were not visible to the naked eye (plate 101); after four days of growth the ascospore colonies were 1-4 mm. in diameter while the pycnospore colonies showed an average diameter of 400  $\mu$ . The time of appearance of the yellow centers in the colo-



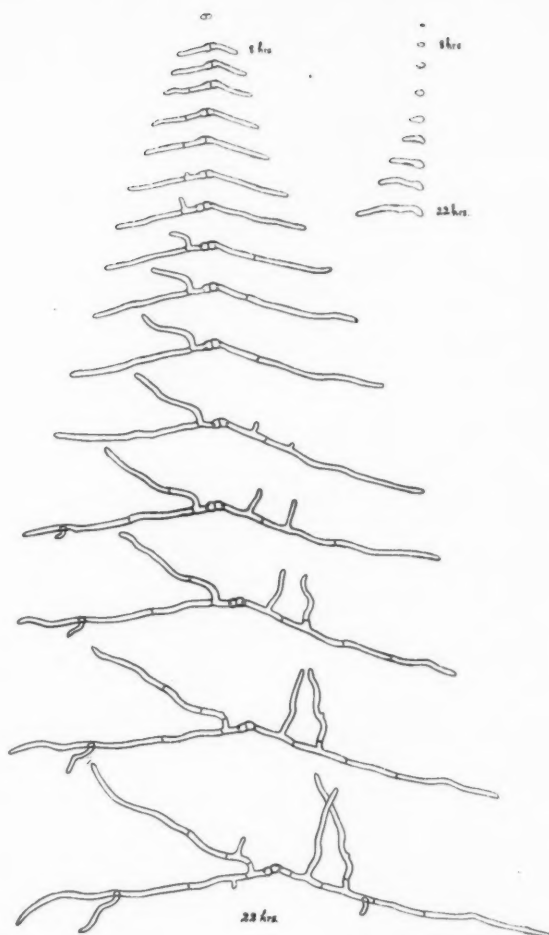
GERMINATION OF PYCNOSPORES



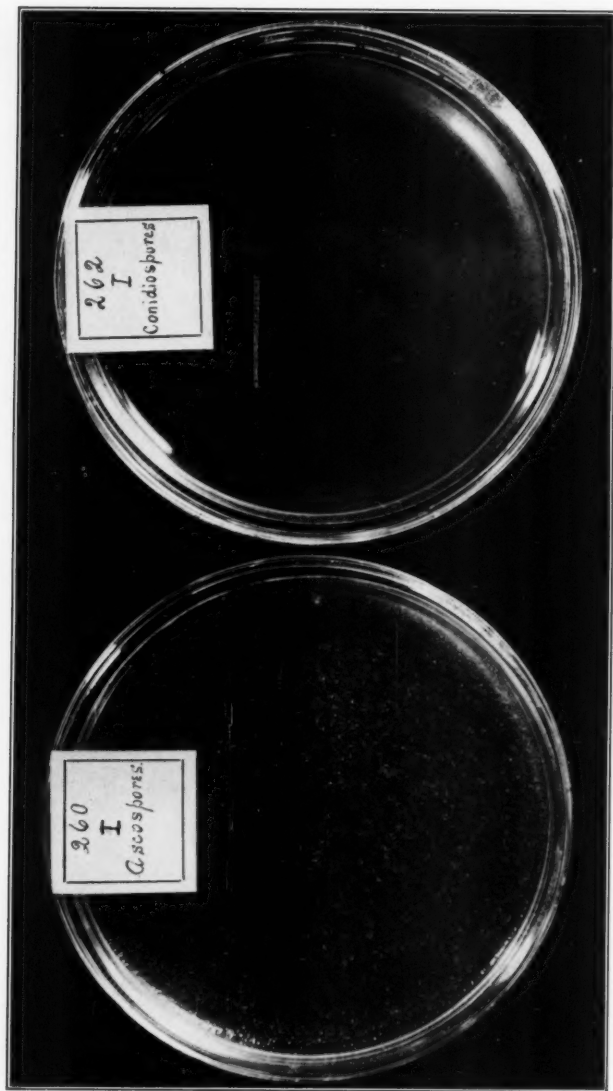


GERMINATION OF ASCOSPORES





SERIES SHOWING COMPARATIVE GROWTH IN HANGING DROP CULTURES



COMPARATIVE GROWTH FROM ASCOSPORES AND PYCNOSPORES

nies does not appear to be of importance since this varies according to crowding, depth of medium and origin. The reliability of this method for differentiating pycnospore and ascospore colonies has been substantiated by numerous cultures, but the importance of holding the cultures at a constant temperature must not be overlooked.

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#### EXPLANATION OF PLATES

##### PLATE XCVIII

Germination of pycnospores in 3 per cent. dextrose agar, plus 10, at 22° C: 1, after 12 hours; 2, after 16 hours; 3, after 22 hours; 4, 5, 6, after 36 hours. These illustrate the linear and the Y-types of germination.

##### PLATE XCIX

Germination of ascospores in 3 per cent. dextrose agar, plus 10, at 22° C. 1-4, a series showing stages in the growth from a single spore: 1, at 11:45 A.M.; 2, at 2:45 P.M.; 3, at 4:45 P.M.; 4, at 7:45 P.M.; 5, 6, 7, after 24 hours. In 4 each cell has produced two hyphae; in 5 one cell has produced two hyphae, while a strong lateral has grown out from the main axis just beyond the other cell of the spore; in 6 one cell has produced a short lateral but no terminal hypha; in 7 one cell of the ascospore failed to produce a germ tube.

##### PLATE C

A series of drawings showing the comparative growth from an ascospore and a pycnospore in 3 per cent. dextrose agar, plus 10, at a temperature of 25° C. After eight hours drawings were made at hourly intervals for the ascospore series and every two hours for the pycnospore series.

##### PLATE CI

Poured plate cultures of ascospores and pycnospores to show comparative growth in 3 per cent. dextrose agar, plus 10, at a temperature of 25° C. Photograph taken after three days of growth. Pycnospore colonies not yet visible to the naked eye.

## NEWS AND NOTES

Dr. Frank D. Kern has been appointed professor of botany in the Pennsylvania State College.

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Professor E. J. Durand of Missouri State University was a recent visitor at the New York Botanical Garden.

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Professor Mel. T. Cook delivered a lecture in the museum building of the New York Botanical Garden on June 14. The subject of the lecture was "Diseases of Fruit Trees."

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Mr. Guy West Wilson, graduate student in Columbia University during the past year, has been appointed special agent by the United States Bureau of Plant Industry for the investigation of the chestnut blight fungus and its relation to tannin and other plant products. He is associated in this work with Professor Mel. T. Cook at Rutgers College, New Brunswick, New Jersey.

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The New York Botanical Garden received in July a collection of 213 specimens of fungi and slime moulds from Porto Rico, collected by J. R. Johnston.

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The *Botanical Gazette* for June contains an article by Howard S. Reed and J. S. Cooley on the transpiration of apple leaves infested with *Gymnosporangium*. A retardation of transpiration in the diseased leaves has been shown. Since it is known that transpiration and growth are intimately associated it is believed that the decrease in transpiration in the diseased leaves may be one of the factors in determining the bad physiological condition of such trees.

Bulletin No. 281 of the Bureau of Plant Industry of the United States Department of Agriculture contains a discussion by L. L. Harter and Ethel C. Field on a dry rot of sweet potatoes caused by a fungus which has been named by them *Diaporthe Batatatis*. The fungus is thought to represent the perfect stage of *Phoma Batatae* Ellis and Halsted. The fungus is not a vigorous parasite and the disease is principally a storage trouble and is characterized by a drying and shriveling of the potatoes with the pycnidia forming on the surface. In the greenhouse the pycnidia also occur on the leaves and stems as well as the roots of the infected plants.

It is suggested, in order to prevent the spread of the trouble, that diseased potatoes should be cooked before being fed to stock. Diseased potatoes should not be used for fertilizer. Sterilization of seed bed is also suggested. No experiments were conducted in controlling the disease.

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In farmers' bulletin No. 544, W. A. Orton summarizes the principal potato-tuber diseases and discusses the best means of eliminating or controlling them and thereby materially increasing the potato yield. It is claimed that the potato yield is only about one half what it might reasonably be expected to be per acre.

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In *Science* for July 11 an article appears by Professor H. L. Bolley, of the North Dakota Agricultural College, on the complexity of the microörganic population of the soil. The article is in part an answer to one by E. J. Russell of Rothamsted Experiment Station which appeared in *Science* for April 4.

Professor Bolley agrees with Russell in many of his statements but takes exception to assuming that protozoa are the principal crop-limiting factor in deteriorated soils. Bolley claims that if we have purified seedlings placed in a purified soil they show no tendency to deteriorate. He also claims that species of fungi such as *Fusarium*, *Alternaria*, *Helminthosporium*, etc., in the soil are the real crop-limiting factors, aside from mineral elements and atmosphere, and that crop deterioration is probably a problem of crop sanitation as involved in infectious diseases. According to this theory sterilization is beneficial in that it destroys harmful fungi, the chief crop-limiting factors.

Circular No. 131 of the Bureau of Plant Industry contains a paper by Dr. C. L. Shear and Neil E. Stevens on the culture characters of the chestnut blight fungus and its near relatives. *Endothia parasitica* (Murrill) Anderson & Anderson has as its near relatives, *Endothia gyrosa*, *Endothia radicalis* and a variety of the latter species.

More than two thousand cultures of these fungi were made in order to study the behavior of the various species on different kinds of culture media. The results of these studies indicate that the different species have constant and easily recognized culture characters. *Endothia parasitica* can be distinguished by the peculiar orange-colored surface growth produced at the bottom of the potato agar slants. The early appearance of the orange color of the mycelium is also characteristic and ordinarily sufficient for identification.

On corn meal, *Endothia parasitica* is characterized by numerous small pycnidia and the absence of color changes in the medium. As compared with *Endothia parasitica*, *Endothia radicalis* is characterized by fewer and larger pycnidia which also appear at a later stage and by the perilla purple reaction of the medium; *Endothia radicalis mississippiensis* by the larger pycnidia and the orange chrome color of the mycelium appearing at the end of the week; and *Endothia gyrosa* by its tardy *spore production* and the formation of elevated or subcolumnar pycnidial stromata.

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In order to make our herbarium records more complete, the New York Botanical Garden desires fresh specimens of any of the fleshy cup-fungi (Discomycetes) either large or small which are suitable for colored drawings or photographs. Do not hesitate to send specimens because they are "common." The term common as applied to these things is purely a relative term. Species which are common with you may be very uncommon in neighboring localities.

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Circular No. 216 of the Forest Service of the United States Department of Agriculture, by W. H. Long, forest pathologist, calls attention to the effect of forest fires on standing hardwood

timber. Scars caused by comparatively insignificant fires furnish gateways through which insects and rot-producing fungi enter the tree. In spite of this fact, it is often claimed that small fires do not injure the forests and the claim is sometimes made that they are even beneficial. Studies made by the author of the article in Arkansas show that the continuous burning of the forests is causing annual losses of thousands of dollars. Most of this loss is caused by the indirect effect of the fire in paving the way for heart rot fungi and harmful insects. Most of these evil effects might be eliminated by coöperation of the people in preventing all fires, both large and small.

---

A short paper on "The production of a promycelium by the aecidiospores of *Caeoma nitens*" by Otto Kunkel in the July number of the Torrey Bulletin is of especial interest to students of the rusts. *Caeoma nitens*, the common orange leaf rust of the blackberry, has been considered the aecidial stage of *Puccinia Peckiana* Howe, both Tranzschel and Clinton having claimed to establish the connection through infection experiments. Kunkel, however, finds that these aecidiospores are functionally teleutospores. On germination they regularly give rise to a septate promycelium and sporidia. The normal promycelium consists of five cells four of which are uninucleated while the basal cell lacks a nucleus. Each nucleated cell produces a sporidium on a sterigma. The sporidia germinate immediately producing either secondary sporidia or germ tubes. Cytological studies of *Caeoma nitens* by Olive and Kurssanow have shown that a uninucleated mycelium precedes the formation of the aecidium and that the binucleated condition is brought about by cell fusions. The aecidiospores are binucleated. Kunkel's further observation on the germination of these aecidiospores suggests that nuclear fusion occurs in the aecidiospore and is followed by the reduction divisions in the promycelium. If this should prove to be the case the mycelium produced by infection with sporidia would be uninucleated and the life cycle of the fungus would be complete. *Caeoma nitens* would thus be a complete rust with a single spore form. This condition would be quite comparable to that found in several species of *Endophyllum* the only essential difference being that in species of

*Endophyllum* the aecidium is of the cup type. The determination of the complete life history of *Caeoma nitens* must await further infection experiments. It is of interest that this method of germination should have so long escaped detection in such a widely distributed and well known rust.—F. D. Fromme.

*Phytopathology*<sup>1</sup> for June contains a paper by Doctor W. C. Sturgis on *Herpotrichia* and *Neopeckia*. In this paper Doctor Sturgis calls attention to the similarity of *Neopeckia Coulteri* (Peck) Sacc. and *Herpotrichia nigra* Hartig. He mentions having seen only one reference<sup>2</sup> to *Herpotrichia nigra* in American literature. In this connection it might not be out of place to call attention to a preliminary note on these two species in a report of the conference of the scientific staff and students of the New York Botanical Garden two years ago, as follows:<sup>3</sup>

"Mr. Fred J. Seaver showed specimens of two fungi (*Neopeckia Coulteri* and *Herpotrichia nigra*?) which occur as parasites on various coniferous trees at high altitudes in the Rocky Mountains. The two fungi are so much alike that they can be distinguished only by microscopic examination of the spores and for this reason the species have been hopelessly confused and most of the specimens in our collections are incorrectly named. So far as our observations have gone the one species (*Neopeckia Coulteri*) occurs only on species of pine, while the other (*Herpotrichia nigra*?) occurs on spruces and firs but never, so far as observed, in America on pine.

"*Herpotrichia nigra* was originally described in Europe and has been reported on both spruces and pines as well as on other coniferous trees. Examination of various European specimens of this species shows the spores to be much smaller than those examined in American specimens. Whether this difference in size which is very marked is due to the fact that the spores are immature is uncertain. Attempts to secure specimens of type material in order to determine the identity of the European species have so far been unsuccessful.

<sup>1</sup> *Phytopathology* 3: 152-158. pl. 12, 13. 1913.

<sup>2</sup> F. S. Earl in Green's *Plantae Bakerianae* 1: 27. 1900.

<sup>3</sup> *Jour. New York Botanical Garden* 12: 159. 1911.

"The fact that this European species occurs on both spruces and pines while the American specimens which are thought to be identical does not occur on pine and that this difference in habitat is accompanied by a difference in the size of the spores suggests the possibility that the American specimens may constitute a species distinct from the European.

"The pine inhabiting species of America (*Neopeckia Coulteri*) which is very different from the preceding species in spore characters is unknown to Europe. The results of these studies will appear more in detail in a paper to be published later."

Notes were in hand for the publication of a more extended paper on this subject with illustrations, but since this has been very well done by Doctor Sturgis it is no longer necessary. The paper covers the ground thoroughly and is accompanied by two plates showing both the gross and microscopic characters of the two species.

In the work on *Herpotrichia nigra* at the Garden some attempts were made to grow the species on culture media. The spores were found to germinate very readily and considerable mycelial growth was produced but no fruiting bodies were formed.—  
*F. J. Seaver.*

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